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Domestic Water Pricing with Household Surveys:

A Study of Acceptability and Willingness to Pay in Chongqing, China

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Abstract

In determining domestic water prices, policy makers often need to use information about the demand side rather than only relying on information about the supply side. Household surveys have frequently been employed to collect demand-side information. This paper presents a multiple bounded discrete choice household survey model. It discusses how the model can be utilized to collect and analyze information about the acceptability of different water prices by different types of households, as well as households' willingness to pay for water service improvement. The results obtained from these surveys can be directly utilized in the development of water pricing and subsidy policies. The paper also presents an empirical multiple bounded discrete choice study conducted in Chongqing, China. In this case, domestic water service quality was seriously inadequate, but financial resources were insufficient to improve service quality. With a survey of about 1,500 households in five suburban districts in Chongqing Municipality, this study shows that a significant increase in the water price is feasible as long as the poorest households can be properly subsidized and certain public awareness and accountability campaigns can be conducted to make the price increase more acceptable to the public. The analysis also indicates that the order in which hypothetical prices are presented to respondents systematically affects their answers, and should be taken into account when designing survey instruments.

This paper—a product of the Sustainable Rural and Urban Development Team, Development Research Group—is part of a larger effort in the department to address environmental governance issues in the developing countries. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at hwang1@worldbank.org.

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TABLE OF CONTENTS

ACRONYMS

CQPMO	Chongqing World Bank Project Management Office
CVM	contingent valuation method
MBDC	multiple bounded discrete choice
NPC	National People’s Congress
WTP	willingness to pay

I. Introduction

With an increase in population and a decrease in available freshwater resources, water scarcity has become a more and more pressing issue worldwide. According to Nature (2008), over a billion people around the world lack access to safe drinking water and over two billion have little or no sanitation. UNEP (2000) predicts that by 2025, two-thirds of the world's population will live in water-stressed regions with per capita water less than 1,700 m^3 per year. Although domestic water use is not a major part of water consumption in the world today, it plays a crucial role in people's daily life, and it is directly related to social welfare and public health issues. Therefore, the efficient use of limited domestic water resources is one of the central concerns of policy makers.

Water pricing is an effective mechanism to manage water use. Switching to a more appropriate price scheme can adjust inefficient levels of domestic water use by changing household water demand. However, water pricing has been a difficult issue for both governmental and nongovernmental decision makers. Developing countries, which usually suffer from inadequate water supply facilities and lack sophisticated and comprehensive water pricing systems, are in need of more practical and effective water pricing methods.[2]

Due to both their complexity and importance, methodologies for water pricing have been widely studied. Water price-makers usually apply one or both of the following strategies to decide domestic water price levels: (1) supply-side based strategies, and/or (2) demand-side based strategies. The supply-side based strategies primarily focus on cost-revenue efficiency, while the demand-side based strategies principally focus on affordability for users and social equity. OECD (2003a) discussed nine categories of pricing strategies according to the forms and underlying considerations of water tariffs: (1) no water charge, (2) fixed water fee, (3) flat uniform water rate, (4) decreasing block rate, (5) increasing block rate, (6) average cost pricing, (7) marginal cost pricing, (8) two-part tariff, and (9) peak load or seasonal pricing.

Affordability is an essential concern in water pricing decision making by a government. Affordability, measured by the ratio of a household's water expenditures to its income, has to be taken into consideration in determining price levels to ensure that the fundamental water needs of the poor can be met. Studies suggest that water consumption expenditures should not exceed a "burden-threshold" of the household's total income (OECD 2003a). In general, as long as the cost of potable water to a household does not exceed 5 percent of the household's total expenditure, the water price is considered "affordable" (Fankhauser and Tepic 2007).

However, the burden threshold may be different for different countries or regions, as well as for different groups of households, depending on factors such as the scarcity of water, tradition, and household income. For policy makers, an assessment of the acceptability of a price by households is as important as an affordability assessment.

[2] In most of the developed countries, water pricing is still an issue of great concern (Garcia 2004).

To assess the acceptability of a water price and better estimate households' willingness to pay (WTP) for water services, this study introduces a multiple bounded discrete choice (MBDC) household survey model and discusses how the model can be used for making better pricing and subsidy policies. With the MBDC survey approach, households are presented a list of potential prices of water supply and are asked to select a level of acceptance for each of the prices offered. With this approach, a mean WTP for a specific level of water service can be estimated for each household and the acceptability of different groups of households can be analyzed for each of the potential prices.

In this study, an empirical MBDC was conducted in five districts of the Chongqing municipality in China. In this city, domestic water service quality is seriously inadequate and financial resources are insufficient to improve service quality. About 1,500 heads of households were interviewed. We assessed household attitudes toward various prices and willingness to pay for an improved water service. We also tested the ordering effect of the price list with the MBDC model.

The following section of this paper presents and discusses the methodology of the WTP and acceptability assessment. Section III presents the household survey in Chongqing. Section IV presents the results of the analyses of acceptability, affordability, and willingness to pay for water service improvement in Chongqing. Section V concludes the paper.

II. Methodology

Domestic Water Pricing

Market-based methods, which enable the demand and supply relationship to play a crucial role in price determination, are mostly used in irrigation water and industrial water pricing (Johansson 2000). This approach has not been widely considered for household water pricing because social equity is at least as important as efficiency in determining domestic water prices.

Due to many differences in the availability of water resources, market practices, and government institutions, countries around the world are applying a variety of household water pricing strategies. These include no domestic charges (Ireland and Northern Ireland), flat-fee charges (Iceland, Scotland, Norway, New Zealand, and part of Canada), single volumetric charges (Eastern Europe), two-part tariffs (most of OECD Europe), varied volumetric tariffs (the rest of Canada, Australia, Luxembourg, and the United States), and increasing block tariffs (OCED Asia, Belgium, Mexico, and the Mediterranean countries), (OECD 2003b). Price levels in these countries also vary due to the availability of water resources, level of government subsidy, and affordability (OECD 2003b).

For domestic water supply, nonvolumetric schemes are sometimes used for pricing that do not include a fee or set a fixed charge independent of the amount of water consumed. More frequently, volumetric schemes can be structured as a two-part tariff, flat-block tariff, increasing block tariff, or decreasing block tariff. The wastewater treatment fee is usually included in a water tariff (WB 2007).

In terms of how to capture the value of water and determine an appropriate water tariff, current pricing mechanisms can be divided into (a) supply-side strategies, with a focus on balancing the investment and revenue of the water supply service; and (b) demand-side strategies, with a focus on capturing the value of water use to users at given prices, or reflecting their willingness to pay (WTP) for the water supply service.

In classical economic theory, efficient water pricing should be able to change instantaneously based on the demand and supply relationship of the resource (Ehemann et al. 2001). Price inefficiency may be caused by (a) an incorrect estimation of the average price; (b) a low evaluation of the social value of water; (c) weak enforcement of economic regulation by local governments; or (d) a nondiscriminatory price (Garcia and Reynaud, 2004; Renzetti 1992). Economists have developed various models to try to capture the real costs of providing water to households and to make sure users react to the price signal by adjusting their water use rationally and rapidly. However, these pricing models are based on a series of assumptions and estimates. Estimates used in almost all models include the amount of water resources available; the monetary value of water resources; the expenditure for the water supply; water demand; the price elasticity of water demand; marginal social costs and benefits; and the social welfare utility. These estimates are not accurate for several reasons. First, recorded water supply expenditures do not reflect the full social cost because they do not include the value of water, which is usually assigned to a municipal utility with no cost. Second, since demand and customer preference are considered exogenous in cost calculation, they are not able to capture the consumers' value of water and related social welfare (Renzetti 1991; Garcia and Reynaud 2004). Third, it is difficult to estimate actual domestic household water use, even based on actual water drawn, because there may be water loss due to leakage or transportation (Zhou and Tol 2005). In addition to these common problems in assumptions, each pricing mechanism has its own shortcomings.[3] More importantly, supply-side strategies are unable to take into account social equity or affordability concerns, while demand-side strategies are able to capture the price level the public considers "acceptable" or "affordable." Demand-side strategies are thus more useful in assisting decision makers in setting water prices.

Many countries and cities have used the willingness to pay (WTP) for water services to determine desirable water prices. WTP reveals consumers' willingness to forgo certain benefits in exchange for others. This concept is widely used in measuring the value of environmental benefits or public goods, and is usually used to estimate how much the public is willing to sacrifice in exchange for better supplies of a public good.

When a water supplier decides to improve its water supply service, it has to consider the public's ability to afford higher prices when in deciding how much to invest. Whether a reform can be successful largely depends on how much more consumers are willing to pay to purchase the improved service. The WTP pricing scheme can help decision makers capture and estimate consumer demand for improved services (Pattanayk et al. 2006). In estimating WTP, economists can apply an indirect approach by observing the behavior of consumers and then calculating the WTP based on the time and money forgone to obtain certain goods. Alternatively, they can use a direct approach such as the contingent valuation method (Raje et al. 2002).

The contingent valuation method (CVM) is a straightforward measurement to determine the public's WTP based on the consumer demand theory. It has been widely used and reviewed (Mitchell and Carson 1989). There are several approaches, including the traditional open-ended method, the dichotomous-choice method, and the multiple-bounded discrete choice stochastic approach (Wang and Whittington 2005). CVM is a stated preference method that minimizes the expenditure of the consumer subject to his utility constraint. Despite criticism, it is used in many resource valuation studies. CVM-derived values such as WTP are contingent on the level of information provided by the the respondents and the extent of information provided by the survey. However, poorly designed or implemented questions may cause bias in the results.

By studying the attitude of the public toward various combinations of a higher price and improved service, CVM has the advantage of capturing the public's reaction to each pricing level. As a result, the price maker can better balance the goal of satisfying the

[3] For example, both long-run and short-run marginal cost pricing, although it is thought to be able to achieve the maximized social welfare, has some practical difficulties (Garcia and Reynaud 2004).

public’s water need and generating as much revenue as possible to recover the investment and cost.

Since they only provide the mathematical average value of WTP to society, traditional CVM methods are not capable of accounting for the affordability of low-income groups. For example, the estimated WTP drawn from a discrete choice model is higher than the value acceptable to about half of the respondents, who are usually more sensitive to price change. In other words, these methods are not able to take into account the affordability of vulnerable groups, such as low-income households or populations with poor access to the water supply. Consequently, they cannot completely capture the equity component. Moreover, traditional CVM methods are incapable of providing sufficient information about WTP at the individual level beyond the respondent’s attitude toward the specific proposed price, and thus cannot inform decision makers about how their response would react to price changes.

Assessment of Acceptability and Willingness to Pay

To overcome the shortcomings of the traditional CVM method, this study further develops the multiple-bounded discrete choice model (MBDC), (Welsh and Poe 1998; Wang and Whittington 2005). In this model, affordability, acceptability, and willingness to pay at the individual level can be assessed by a household survey. By applying this improved method, we can estimate the (a) public’s acceptability of each water price; (b) characteristics of respondents in each category of acceptance; (c) WTP; and (d) affordability for each subgroup in the society. By providing more details, this method can help decision makers set the household water price.

Inspired by the “return potential” format used by sociologists to explore the strength of social norms and satisfaction levels across varying conditions, Welsh and Bishop (1993) adapted the MBDC questionnaire for contingent valuation estimation. The MBDC format allows each respondent to vote repeatedly on an ordered sequence of referendum thresholds, thereby reducing the impact of the “anchoring” heuristic, which is often much more important in single or double-bounded questions and provides generally more data and the possibility to verify the coherence and credibility of the data. In the MBDC format, for each price the respondent is asked, a scale of “polychotomous choices”—response options ranging from definitely yes, probably yes, not sure, probably no, to definitely no—is also provided to allow respondents to express their level of voting certainty for the referendum.

The responses to these choices under different bid prices can offer an assessment of the acceptability of the prices. Distributions can be drawn on acceptability with different prices. As shown in Wang and He (2008), the MBDC data can also be used to estimate WTP distributions for each individual. Numerical likelihood values can be assigned to the choices, such as 100 percent for definitely yes, 75 percent for probably yes, 50 percent for not sure, 25 percent for probably no, and 0 percent for definitely no. Simulations can be conducted to assess the sensitivity of the numerical value assignment.[4] A two-stage WTP estimation methodology, as proposed by Wang and Whittington (2005), can be applied to calculate the WTP and its determinants. The mean value (μ) and the standard variance (σ) of each individual's WTP can be estimated first and then analyzed by using regressions of individual specific variables.

Assume an individual i has a WTP (Vi). Given a price $t_{ij,}$ the probability for individual i to accept the offer is,

(1) P_{ij} = Prob ($Vi>t_{ij}$) = 1-F(t_{ij})

where F(t_{ij}) is a cumulative distribution function of the random variable Vi, and

(2) $Vi = \mu_i + e_i$

where μ_i is the individual's mean WTP, e_i is the random error with a mean of zero, and σ_i is the standard variance. F(t_{ij}) can be constructed as a function of μ_i, σ_i, and $t_{ij,}$, assuming a normal distribution:

(3) $F_i (t_{ij}) = \Phi[(t_{ij}-\mu_i) /\sigma_i]$

Thus, the estimation model of mean WTP can be written as:

(4) $P_{ij} = 1-F(t_{ij}) + \lambda i$, or

(5) $P_{ij} = 1-\Phi[(t_{ij}-\mu_i) /\sigma_i] + \lambda i$

where λ i is an error term with a mean of zero, and its standard variance δ can be constant for a specific individual but different for different respondents. A maximal likelihood function can be constructed to estimate model (5) and μ_i and σ_i can be estimated for each individual.

After obtaining each individual's mean WTP and the standard variance, models such as linear regressions can be constructed and estimated to perform an internal validity check and to provide a method for projection. Linear models can be constructed as follows:

(6) $\mu_i = \beta_0 + \beta x_i' + e_1$,

(7) $\sigma_i = \nu_0 + \nu z_i' + e_2$

Where x and z are personal specific variables such as income and current water price, etc. β and ν are coefficients to be estimated; e_1 and e_2 are random errors.

Other modeling techniques such as ordered probit or logit can also be employed to analyze the determinants of acceptability responses.

[4] For more discussion, see Wang and He (2008).

III. Chongqing Survey

Water Pricing in China

The China Water Law, China Pricing Law, and China Administrative Regulation on Urban Water Supply Pricing (1998) govern domestic water pricing in China. The water tariff is volumetric, which may contain a water price, wastewater treatment fee, and water resource fee.

According to the Pricing Law, the water price consists of water supply costs, fees, taxes and profits, and net profit, which is not expected to exceed 8 to 12 percent of net capital investment. Currently, most cities in China are applying a two-part pricing mechanism, which includes a water price and a wastewater treatment fee. Big cities—such as Beijing, Shanghai, and Guangzhou—apply increasing block pricing to generate more incentives to save water in the near future (HWCC 2006).

Water tariffs in China vary from city to city. In major cities, water prices range from 1 to 3 yuan per ton. Appendix I lists the water prices and wastewater treatment fees in the major cities at the end of 2006. As part of the water tariff, a wastewater treatment fee is collected together with the water price, but paid to water treatment centers or sewage centers.

The 1996 Water Pollution Prevention and Control Law require all users of urban sewage systems to pay for the wastewater treatment service. Currently, the wastewater treatment fee varies from 0.25 to 1 yuan per ton. As defined by the 2006 Ordinance on Water Permits and Water Resource Fee Management, the water resource fee represents the value of water resources as the raw material of water supply service and is paid to the water resources management department, pricing department, and finance department of the government. The local water resource department determines the water price based on the water resources available and society's affordability. Since the allocation of water resources is very unbalanced within China, the water resource fee has a big variance, ranging from 0.02 yuan per ton in Changsha to 1.10 yuan per ton in Beijing (Rednet 2006; WB 2007).

Despite the pricing mechanism described in the Price Regulations, household water supplies have been heavily subsidized in China. In reality, however, vulnerable groups actually benefit from the water subsidy the least, and are even harmed by such a policy. On the one hand, low-income families tend to use less water compared to high-income families. As a result, low-income families—the group targeted to benefit from subsidy policies—benefit less than the high-income group. On the other hand, heavy government subsidies distort the cost-effectiveness of the market, create incentives for excessive water consumption, and cause externality problems; as a result, they harm the water supply industry. With fewer alternatives to obtain water, the vulnerable groups suffer more due to a poor water supply system. Therefore, more price reforms are needed to increase water tariffs and reduce subsidies (WB 2007).

In addition to achieving better social equity and improved cost recovery, increasing the water price is also recognized as an effective way to promote water conservation by the National People's Congress (NPC). Article 24 of the Pricing Regulation establishes the principles for water tariff adjustment. To improve cost recovery, any water tariff adjustment should take into account the development of the water supply industry, the need for economic development, the public's daily need for water, water conservation, affordability for consumers, and the pricing mechanism.

The water tariff has been adjusted several times in many areas in China. For instance, in Beijing the water price increased from 0.80 yuan per ton in 1997 to 3.70 in 2004. In the central area of Chongqing, it rose from 0.85 yuan/ton in 1999 to 2.80 in 2006 (WB 2007). However, more water price reforms are still needed to achieve true efficiency in the domestic water market.

The Chongqing Survey

Chongqing, located in western China, is one of the largest and most populous municipalities in China. The population of the urban area of Chongqing was 4.1 million in 2005. In 2006, the nominal GDP of the Chongqing municipality was 348.62 billion yuan ($45.2 billion), an increase of 11.5 percent from 2005. Its per capita GDP was about 12,000 Yuan (or $1,610) (NSB 2006).

Due to its location, the city has very limited surface and underground water resources. The city's household water supply service has been monopolized and under heavy subsidy by the government. Current water prices in survey areas in Chongqing range from 1.8 yuan/ton to 2.8 yuan/ton. This price does not include sewage treatment costs, which are entirely absorbed by the municipal government.

Improving water supply service in several regions outside of Chongqing urban proper, which are characterized by high water scarcity, has been under discussion. In the summer of 2006, the Chongqing World Bank Project Management Office (CQPMO) hired professors and graduate students of Chongqing University to conduct in-person interviews of the heads of selected households, with technical support by World Bank experts. The major purposes of the survey was to better understand domestic water use and to assess household willingness to pay for improved domestic water service, so that sound policy proposals on water tariff structure and water service improvement could be provided by the municipal government.

The survey focused on five areas where water supply improvement projects were under consideration.[5] In each survey area, several communities were selected to balance the income and water usage level within each region. A random sampling process was run

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[5] The areas include part of Shapingba District, Jiulongpo District, Dianjiang County, Yongchuan County, Tongnan County, and Dianjiang County.

within each elected community to select households to be interviewed.[6] The survey team contacted 1,868 households. A total of 1,502 questionnaires were completed, with a response rate of 84 percent. Among the 1,502 observations, 24 outliers were excluded from the analyses; the remaining 1,478 observations were kept in the sample.

The questionnaire included nine sections: (1) respondent's identification; (2) characteristics of respondent's residential house/building; (3) household water supply and consumption; (4) alternative water sources and solution for water shortage; (5) waste water and water sanitation; (6) WTP; (7) current water costs; (8) health and environmental awareness; and (9) household information. The WTP part adopts the MBDC approach, which covers a price range for water from 0.5 yuan/ton to 15 yuan/ton.

The WTP section of the questionnaire has several components: a question about problems of current water service; a description of new water service plans; the need to raise water tariffs to make ends meet under the new plan; a list of daily water usage and potential savings from the improved water supply service; a reminder that their water tariffs would be the sum of the water fee and sewage treatment fee in questionnaire type A, while no reminder in type B; and MBDC questions. Appendix 2 provides details of the WTP section in the questionnaire.

Major Statistics of the Survey

Table 1 provides statistics of major indicators.[7] As shown, about 91 percent of the households surveyed have a piped water supply connection, and only 23.1 percent of the households are satisfied with the current water supply service. Average household water consumption is about 6.2 tons per month. The average water price the households pay is 2.18 yuan/ton. The average household income is about 1,211.1 yuan. The average water expenditure is about 1.1 percent of income. Of the households surveyed, 50.3 percent were located in urban towns. Seventy percent of the survey respondents were female, and the average education level of the respondents was between middle and high school. More analysis of the survey is provided in the next section of this paper.

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[6] For practical and statistical reasons, the sample size in each community was no smaller than 30.

[7] For more statistics of this survey, see World Bank (2007).

IV. Empirical Analysis

Acceptability

Table 2 provides the statistics of acceptability of households on each price listed in the multiple-bounded discrete choice card. At the lowest price, 0.50 yuan/ton, 92 percent of the households indicated that the price was very low, and 7.8 percent of households indicated there was no problem for them to pay at this price, and the remaining 0.2 percent could also barely accept the price. Therefore, about 100 percent of the households could accept the price. This percentage dropped to 99.5 percent at a price of 1 yuan/ton, 97.4 percent at 1.5 yuan/ton, 81.3 percent at 2 yuan/ton, and 56.2 percent at 2.5 yuan/ton. Less than 40 percent of the households surveyed thought they could accept a price of 3.0 yuan/ton. At a price of 3.5 yuan/ton, 28.9 percent of the households thought the price was high and 53.6 percent thought it was too high. At 4 yuan/ton, 94.6 percent of the households thought the price was either high or too high.

Figure 1 presents Table 2 graphically. An acceptability of 50 percent corresponds to a price of about 2.75 yuan/ton. Figure 2 presents the changes in attitudes of households at the three most **concerned** prices—2.5, 3, and 3.5 yuan/ton. Among those with minor negative attitudes, or rejection, the percentage of households does not change significantly. However, the percentage of households with strong rejection increases from 18.1 percent at 2.5 yuan/ton, to 36.1 percent at 3 yuan/ton, and to 53.6 percent at 3.5 yuan/ton.

This analysis shows that if the price were to increase to 2.5 yuan/ton, an increase of about 15 percent from the current average price of 2.18 yuan/ton, more than 50 percent of the households could immediately accept the change, a quarter of the households would have some difficulties, and 18 percent of households would feel the increase was too much.

WTP Estimation

Table 3 shows the estimated mean WTP by using model (5). As discussed before, for the purpose of the analysis, numerical likelihood values of accepting the prices need to be assigned to the verbal expressions. In the estimation, a "strong rejection" was given a probability value of 0.001 percent.[8] A simple "rejection" was given a value of 25 percent; "barely acceptable" 50 percent; "acceptable" 75 percent; and "easily acceptable" was given a value of 99.999 percent.[9]

Both the mean WTP (μ) and the standard variance of the WTP (σ) can be estimated for each individual household based on model (5). Table 3 gives the percentiles and the mean values. The mean of the household WTP was 2.37 yuan/ton, with a sample standard variance of 1.31 yuan. The medium value of the household WTP was 2.27 yuan/ton. The

[8] The number should be zero. However, a value of zero will generate infinity in the model estimation.
[9] Simulations about these assumptions are given later.

mean value of the household WTP standard variance was 1.53 yuan, which indicates the uncertainty level of the households in their WTP. The estimated household WTP was used in the following analyses of water burden and internal validity.

The mean WTP estimations changed slightly when the “barely acceptable” response was assigned a value of 60 percent. The result is 2.54 yuan. Table 2 in the appendix provides details of the simulation. The mean values for WTP of different income groups were not significantly different.

When a household’s WTP value is assumed to be the highest price at which the head of the household feels “barely acceptable” and is not rejected, the average WTP would be 2.48 yuan/ton. If a household’s WTP value is assumed to be the highest price at which the head of the household “rejects” but does not reject “strongly,” the mean WTP will be 3.28 yuan/ton.[10]

Burden and Affordability

Table 4 presents a comparison of the current water price, WTP, and water expenditure by income groups. Water prices vary by region, and therefore there is no significant difference between water prices associated with different income groups, even though high average prices are found within low-income groups. The mean WTPs are the lowest with the lowest three income groups. In general, the higher the income is, the higher the WTP.

While in general the lowest water uses are found in the lowest income groups, the share of water expenditure in income is higher with the lower income groups. The share of the lowest income group, which has an average monthly income less than 200 yuan, is 6 percent. This exceeds the conventionally recognized “burden threshold” in water expenditure, which is 5 percent. For the second lowest income group, the share is 3.1 percent. These two lowest income groups account for 7 percent of the total number of households. For income groups with a monthly income higher than 1,000 yuan, which accounts for about 62.9 percent of the total number of households, water expenditure is less than 1 percent of income.

The WTP as a percentage of income is also higher with the lower income groups. The pattern is compatible with water expenditure. This is probably caused by the fact that WTP is usually influenced by the current price or expenditure.

Table 5 compares the price, WTP, and expenditure by region. Region 1 is unique. The average WTP and water expenditure burden are the highest, while the ratio of households with piped water supply is the lowest—only 66 percent of households have piped water

[10] The theoretical justification for this assumption is that when a price is high enough to make a consumer change his/her behavior—but is not higher than the total value, or total WTP, of water to the consumer—he/she may reject the price proposal, but not reject it strongly. When the price is higher than the total WTP, he/she may reject it strongly.

supply connections. Region 1 also has the highest water price—2.50 yuan/ton, while region 5 has the lowest—1.8 yuan/ton.

Table 6 shows the acceptability distributions at the three most concerned prices (2.5, 3, and 3.5 yuan/ton). Forty-eight percent of households reject the price of 2.5 yuan and 85 percent of households reject the price of 3.5 Yuan. At the price of 2.5 yuan, the average income of the households who reject the price is lower than that of those who accept, but at the price of 3.5 yuan, the average incomes are almost the same. At both prices of 2.5 and 3.5 yuan/ton, those households who reject the price consume less water, and the burden of water expenditure is also lower.

Table 7 shows the lowest income group—with a monthly income lower than 400 yuan—at the concerned water prices of 2.5, 3, and 3.5 yuan/ton. At the current price structure, the burden of water use for this group is 3.95 percent. This burden increases to 5 percent at the price of 2.5 yuan/ton, 6 percent at 3 yuan/ton, and 7 percent at 3.5 yuan/ton. These burdens exceed the burden threshold as suggested by OECD, which is 3–5 percent. A subsidy policy may need to be considered.

Determinants of WTP

An econometric analysis of WTP using model (6) is presented in Table 8. There are two major reasons for conducting the econometric analysis. One is to have an internal validity test of the quality of the WTP estimation. The WTP estimate should follow underlying economic reasons and common sense. Another purpose of the econometric analysis is to test the ordering effects of the matrix design of the MBDC approach. Just as with the referendum approach, there may be an anchoring effect of price presentation of the MBDC matrix.

In this study, four different price orders were designed and randomly assigned to the respondents to minimize the potential anchoring effect. In type 1, the question starts at the lowest price and all other prices are ascending. In type 2, the question starts at the highest price and all other prices are descending. In type 3, the most likely prices, 2.5 yuan/ton to 3.5 yuan/ton, are placed in the beginning, and the remaining prices are listed in ascending order. In type 4, the most likely price arrange, 2.5 yuan/ton to 3.5 yuan/ton, are placed in the beginning, and the remaining prices are listed in descending order. Four dummy variables—order 1, order 2, order 3 and order 4—are used to indicate the four types of questionnaire. Another dummy variable, ordernorm, is created to represent those questionnaires that start with the most likely prices.

Another treatment is designed and implemented in the survey to test the wording effect of pricing. About half of the respondents, who received questionnaire type A, are told that the price includes both the water fee and sewage fee, while the other half of the respondents are only told about the water fee.

Four modeling results are presented in Table 8. Model 1 is a linear model. In models 2 through 4, both WTP and income are in log terms. The results presented in Table 8 are generally consistent with economic theory and common sense.

There are four significant socioeconomic variables in the model. Household income[11] is a positive, significant determinant of WTP, just as expected. The elasticity of WTP with respect to income is about 5.8 percent. The current municipal water price is another positive, significant determinant of WTP. The elasticity is about 35.5 percent. Male and urban respondents are willing to pay more.

Variables such as access to the municipal water supply system, satisfaction with the current water supply system, average monthly water use, age, and education did not have significant effects on WTP. The reminder about including the sewage fee in the payment does not have a significant impact on WTP, either.

The impacts of the price ordering are shown as expected. Starting at the lowest price (order 1) has a significant negative impact, and starting at the highest price has a significant positive impact. Beginning at the most likely prices and then listing the remaining prices in ascending order, has a significant negative impact. Starting with the most likely prices does not have a significant impact on WTP.

An additional analysis on the determinants of WTP answers is conducted by using the original verbal answers. A model of ordered probit with clusters is run on the five categorical values of acceptance of the different prices. The results are presented in Table 9, which are almost identical to those obtained with the two-stage WTP modeling approach.

V. Summary and Conclusion

In creating water policies, it is often necessary to collect and analyze information from the demand side as well as using information from the supply side. This paper presents a multiple-bounded discrete choice (MBDC) household survey model and discusses how the model can be used to collect information from the household, analyze the acceptability of different water prices by different households, and estimate households' willingness to pay (WTP) for domestic water service improvement.

With the MBDC format, households are presented with a list of potential prices of water supply and are asked to select a level of acceptance with each of the prices offered. Statistics can be easily provided on how strong the acceptance or the rejection is for each of the prices under consideration, and the groups of households with strong rejections can easily be identified and analyzed. Thus the potential social issues that may be involved in making domestic water policies can be predicted, addressed, and even prevented**.** With

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[11] In the survey, this variable is a categorical variable. An average is assigned to each category based on Chongqing report submitted to the World Bank.

this approach, a mean willingness to pay for a specific level of water service can be estimated for each household. By comparing this WTP information with the cost information from the supply side, the potential economic efficiency issue in deciding the level of service and price can also be addressed.

A survey of 1,500 households was conducted in five districts of the Chongqing municipality, China. The MBDC format was employed. The analyses show that the willingness to pay for improved water service is low—between 2.5 to 3.3 yuan/ton on average, or 1.5 to 2 percent of income—but is significantly higher than the current price, which is about 2.2 yuan/ton on average. The poorer households are willing to pay less in absolute terms, but higher as a percentage of income, reaching as high as 6 percent for the lowest income group. In general, the higher the household income is, the higher the willingness to pay. The higher the current water price is, the higher the WTP. Urban households and male respondents are willing to pay more.

This study also gave a further assessment of household acceptability and burden of water expenditure at three prices—2.5, 3, and 3.5 yuan/ton. The results show that even at the lowest price, 2.5 yuan/ton, about 20 percent of households would strongly reject the price increase. The current water prices in the surveyed regions are between 1.80 yuan/ton and 2.50 yuan/ton. Rejection rates are much higher with the two higher prices. However, the average economic burden to the households is only 1.5 percent, 1.8 percent, and 2.1 percent respectively. The economic burden to the lowest income group—with a monthly income less than 400 yuan—is about 3.3 times as high as the average.[12] While there is clearly room for a water price increase in the surveyed areas, special attention needs to be paid to poor people and to those who strongly reject the increases. A targeted subsidy policy and public awareness campaigns or other public accountability measures may be warranted in order to make the price increases more acceptable.

The MBDC format can help conveniently collect information about households' acceptability of different water prices and willingness to pay for improved water services. However, the results can potentially suffer from biases caused by the order of presenting the water prices to the respondents. This study provided a test on the potential ordering effect and found that the ordering effect did exist. Estimated WTP would be lower if lower prices are presented first, and higher if the higher prices are offered at the beginning. A strategy of randomizing the starting prices is recommended. Further research on this issue is warranted.

[12] This is in contrast with the OECD countries, where, according to OECD (2003a), the burden of household water consumption over household income varied between 2.24 percent in Scotland to 4 percent in England and Wales, with an outlier of .066 percent in America in 1997–2000. The ratio of the lowest-income-group burden to average burden was 1.3–3.1.

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Table 1. Major Socioeconomic and Demographic Variables

Variable Name	Definition	Mean Value	Std Dev.	Min	Max
Water Supply:					
Cityws	1=the household is connected to city water supply system; 0=otherwise	0.908	0.277	0	1
Satisfy	1= the respondent is satisfied with current city water supply service; 0=otherwise	0.231	0.422	0	1
Cwp	Current water price (yuan/ton)	2.18	0.25	1.80	2.50
Avemwu	Average monthly water use (ton)	6.18	8.26	1	250
Personal Information:					
Male	1=male; 0=female	0.70	0.35	0	1
Age	age of the respondent	47.97	9.61	18	84
Edu	education level of the respondent (1=elementary school or less; 2=middle school; 3=high school; 4=vocational school; 5=college; 6=bachelor and above)	2.36	1.03	1	6
Urban	Household location (1=urban; 0=suburban)	0.503	0.5	0	1
Income	Household monthly income (yuan)	1211.1	697.2	132	2676
Questionnaire Treatment					
Wwqtype	1=WTP questions for water service improvement are asked with a reminder that an additional wastewater treatment fee also needs to be paid separately; 0=without a reminder	0.446	0.497	0	1
order1	1=WTP questions in an ascending order of price; 0=otherwise	0.238	0.426	0	1
order2	1=WTP questions in a descending order of price; 0=otherwise.	0.292	0.455	0	1
order3	1=WTP questions start with the most likely prices and the rest in an ascending order of price; 0=otherwise	0.214	0.41	0	1
order4	1=WTP questions start with the most likely prices and the rest in a descending order of price; 0=otherwise	0.256	0.44	0	1
ordernorm	Order3 + order4; 1=WTP questions starts with the most likely prices; 0=otherwise	0.47	0.499	0	1

Table 2. Statistics of Acceptance Responses

Price (yuan/ton)	Strong Rejection (%)	Rejection (%)	Barely Acceptable (%)	Acceptable (%)	Easily Acceptable (%)	Total (%)
0.50	0	0.20	0.95	6.77	**92.08**	100
1.00	0.14	0.47	3.45	32.34	**63.60**	100
1.50	0.74	1.83	19.35	**45.67**	**32.41**	100
2.00	3.92	14.82	**31.73**	**36.06**	13.46	100
2.50	18.06	**25.71**	**30.31**	**19.96**	5.95	100
3.00	**36.13**	**28.21**	**26.05**	6.90	2.71	100
3.50	**53.59**	**28.89**	12.92	3.79	0.81	100
4.00	**71.85**	**22.73**	4.06	1.15	0.20	100
4.50	**83.29**	14.55	1.83	0.27	0.07	100
5.00	**89.95**	9.34	0.54	0.27	0	100
6.00	**95.47**	4.26	0.20	0.07	0	100
7.00	**97.90**	2.03	0.07	0	0	100
8.00	**99.12**	0.81	0.07	0	0	100
9.00	**99.46**	0.47	0.07	0	0	100
10.00	**99.59**	0.34	0.07	0	0	100
12.00	**99.73**	0.27	0	0	0	100
15.00	**99.59**	0.41	0	0	0	100

Table 3. Estimated Individual WTP Distribution (unit: Yuan)

Variable	Percentile	Mean WTP (yuan)	**[95% Conf.**	**Interval]**
Distribution of μ	0	0.33	0.33	0.33
The sample mean of μ is 2.37	10	1.35	1.29	1.39
	20	1.68	1.67	1.70
	30	1.87	1.81	1.89
	40	2.11	2.05	2.11
	50	2.27	2.25	2.29
The sample std. dev. of μ is 1.31	60	2.50	2.48	2.53
	70	2.71	2.69	2.74
	80	2.97	2.95	2.97
	90	3.39	3.34	3.43
	100	8.39	8.39	8.39*
Distribution of σ:	0	0.08	0.08	0.08
The sample mean of σ is 1.53	10	0.42	0.31	0.46
	20	0.65	0.65	0.65
	30	0.81	0.80	0.83
	40	0.96	0.96	0.99
	50	1.10	1.08	1.10
	60	1.25	1.23	1.25
The sample std. dev. of σ is 6.53	70	1.44	1.42	1.46
	80	1.74	1.74	1.79
	90	2.52	2.41	2.63
	100	9.30	9.30	9.30*

μ: the mean of individual WTP; σ: the standard variance of Individual WTP

Table 4. WTP and Water Expenditure by Income Groups

Income Group	% Of obs.	Current Water Price (yuan/ton)	Mean WTP (yuan/ton)	Average Monthly Water Use (tons)	Water Expenditure /Income (%)	Mean WTP /Income (%)
<200	2.7	2.18	1.92	3.72	6.05	5.96
201-400	4.2	2.14	1.74	4.21	3.10	2.18
401-700	11.1	2.17	1.92	4.59	2.08	2.02
701-1000	19.1	2.19	2.11	5.37	1.55	1.49
1001-1500	25.7	2.17	2.20	5.45	0.96	1.02
1501-2000	16.9	2.13	2.16	6.17	0.69	0.69
2001-2500	11.0	2.09	2.19	6.45	0.65	0.70
2501-3000	4.9	2.11	2.14	7.39	0.74	0.75
3001-5000	3.3	2.03	2.27	5.26	0.54	0.62
>5000	1.1	2.14	2.22	6.50	0.63	0.70
Overall	100	2.15	2.12	5.59	1.43	1.43
Lowest Income Group to Average					4.32	4.17

Table 5. WTP and Water Expenditure by Region

Region	1	2	3	4	5
#. of obs. (%)	32.10	18.20	13.40	17.40	18.80
Population (millions)	0.76	0.76	1.07	0.92	0.89
GDP/cap (yuan)	16,600	20,300	7,500	8,100	5,000
% with Piped Water Supply	66	91.4	71.2	98.1	99.3
Water Price (yuan/ton)	2.5	2.05	2.25	2.1	1.8
Average WTP (yuan/ton)	2.61	2.45	2.27	1.49	1.79
Monthly Water Use (ton)	7.13	6.04	5.6	3.26	7.13
Water Use Burden (%)	2.67	0.95	1.01	0.82	1.23
% WTP Burden	2.78	1.14	0.97	0.59	1.22

Table 6. Acceptability and Economic Burden at Prices under Consideration

Price	Acceptability	Strong Rejection	Rejection	Barely Acceptable	Acceptable	Easily Acceptable
2.5 yuan/ton	%	19.8	28.5	30.1	16.5	5.0
	Income	1,087	1,301	1,490	1,548	1,434
	avemwu	4.21	5.29	5.86	6.62	7.39
	Burden	1.22	1.17	1.20	1.63	1.41
3 yuan/ton	%	39.5	29.3	22.4	6.6	2.2
	Income	1,225	1,372	1,575	1,431	1,372
	avemwu	4.81	5.26	6.92	6.28	7.62
	Burden	1.78	1.63	2.35	1.77	2.10
3.5 yuan/ton	%	56.2	28.4	11.4	3.1	1.0
	Income	1,268	1,497	1,492	1,375	1,423
	avemwu	5.08	5.90	6.77	6.82	6.71
	Burden	2.05	2.35	2.36	2.54	2.20

Table 7. Burden of Poorest Households with Income Less than 400 Yuan/Month

Price (Yuan)	burden of low-income group	average burden	ratio of low to average
Current (2.18)	3.95	1.32	2.99
2.5	4.97	1.50	3.31
3	5.96	1.80	3.31
3.5	6.95	2.10	3.31

Table 8. WTP Regressions

	Model 1	Model 2	Model 3	Model 4
Dependent variable				
	WTP	log(WTP)	log(WTP)	Log(WTP)
independent variable				
Income	0.0001026***	0.057892***	0.0582288***	0.0561636***
	0.0000219	0.0095805	0.0096227	0.0100136
Cityws	0.0801782	0.0294668	0.0239479	0.0099459
	0.0558026	0.0279399	0.028052	0.0291706
Satisfy	0.0014649	-0.001029	0.0073955	0.0060255
	0.0381318	0.0191974	0.0191982	0.0199786
Cwp	0.4042867***	0.3550591***	0.3562884***	0.3800915***
	0.0777847	0.0839215	0.0842922	0.0876725
Avemwu	0.001246	0.0007092	0.0009485	0.0010851
	0.0017857	0.0008964	0.0008989	0.0009357
Age	0.0019545	0.0010087	0.0009579	0.0010257
	0.0016269	0.0008166	0.0008202	0.0008538
Edu	0.0249529	0.0087343	0.0096548	0.0104211
	0.01592	0.0079538	0.0079892	0.008316
Male	0.0972388**	0.0600857***	0.060987***	0.0742992***
	0.0433189	0.021718	0.0218148	0.0227041
Urban	0.601073***	0.3045403***	0.3099979***	0.3114547***
	0.0404013	0.0200129	0.0200768	0.0208773
Wwqtype	-0.0221602	-0.0096263	-0.0150638	-0.0175809
	0.0296438	0.0148717	0.0149121	0.0155186
order1	-0.2476063***	-0.1259277***	-0.0866356***	
	0.0418999	0.021011	0.0185558	
order2	0.1264611***	0.0658993***	0.103608***	
	0.0398537	0.019992	0.0174932	
order3	-0.1726949***	-0.0856627***		
	0.0431202	0.0216331		
ordernorm				-0.0195295
				0.0154392
Con_	.5940617***	-.2081305*	-.2498855**	-.2360578**
	.2205951	.1149269	.114904	.1189831
Overall Model Fit				
p-value	0.0000	0.0000	0.0000	0.0000
R-squared	0.2250	0.3207	0.3164	0.2894

***= significantly level at 10%; **=significantly level at 5%; ***=significantly level at 1%.**

Table 9. Modeling Results of Ordered Probit with Clusters

	Model 1 (Linear)	Model 2 (Log)	Model 3 (Log)	Model 4 (Log)
Price	-0.9784036***	-3.2114650***	-3.1969420***	-3.1385760***
	0.0489294	0.0647704	0.0642527	0.0616153
Income	0.0000850***	0.1142358***	0.1152855***	0.1030091***
	0.0000290	0.0294437	0.0294272	0.0297590
Cityws	0.0750475	0.0981813	0.0877810	0.0490508
	0.0902886	0.0888891	0.0864542	0.0871963
Satisfy	-0.0260833	-0.0507603	-0.0257098	-0.0129192
	0.0517393	0.0553318	0.0555057	0.0557280
Cwp	0.0062416***	1.4183950***	1.4111270***	1.4820570***
	0.0010761	0.2436785	0.2467346	0.2484736
Avemwu	0.0020662	0.0022312	0.0028793	0.0030089
	0.0016811	0.0017726	0.0018146	0.0018692
Age	0.0022276	0.0032487	0.0031893	0.0031259
	0.0022173	0.0024151	0.0024262	0.0024371
Edu	0.0370419	0.0424564*	0.0418338*	0.0404976
	0.0226091	0.0251808	0.0254467	0.0255618
Male	0.1669342***	0.1824851***	0.1797122***	0.1843280***
	0.0627674	0.0695493	0.0701688	0.0705243
Urban	0.5606913***	0.6522652***	0.6642754***	0.6739893***
	0.0633573	0.0691374	0.0692701	0.0688321
Wwqtype	-0.0137693	-0.0208664	-0.0347563	-0.0439999
	0.0418498	0.0441029	0.0437986	0.0440300
order1	-0.4085134***	-0.4415177***	-0.3107246***	
	0.0560501	0.0602705	0.0535457	
order2	0.0947692***	0.1061688*	0.2326267***	
	0.0558169	0.0573823	0.0515868	
order3	-0.2749364***	-0.2904492***		
	0.0603581	0.0639889		
ordernorm				-8.38E-06
				0.0431692
Overall Model Fit (Note: cuts are omitted)				
p-value	0.0000	0.0000	0.0000	0.0000
Pseudo R-Squared	0.4685	0.5109	0.5091	0.5024

Figure 1. Acceptance Rate at Each Price

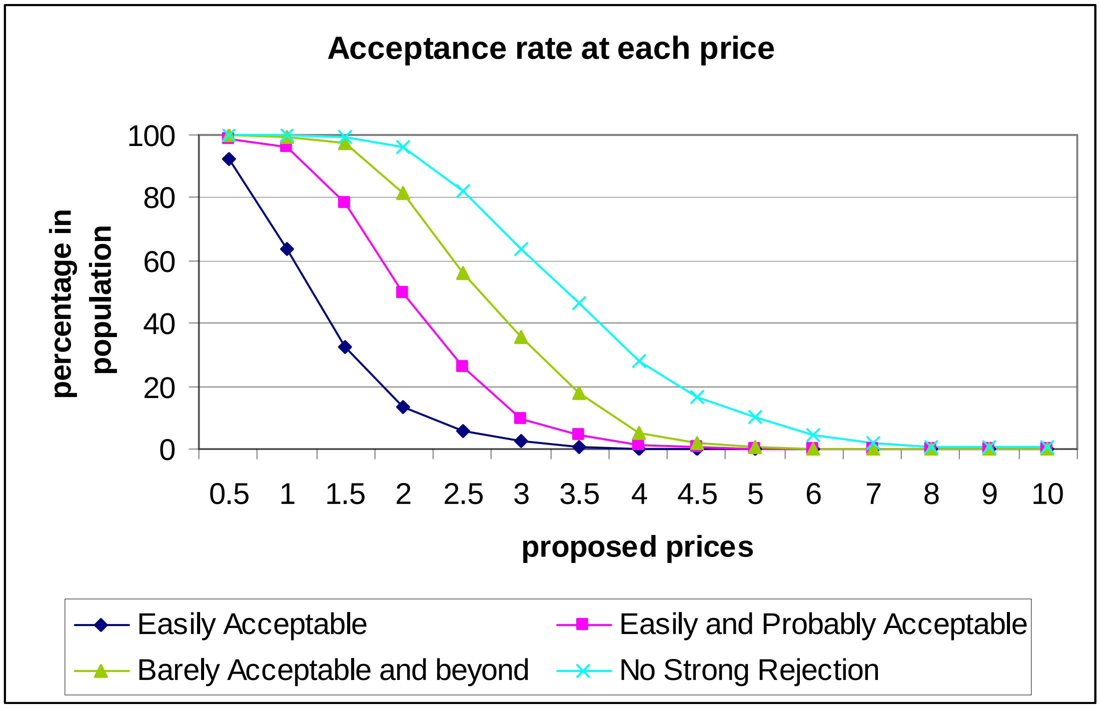
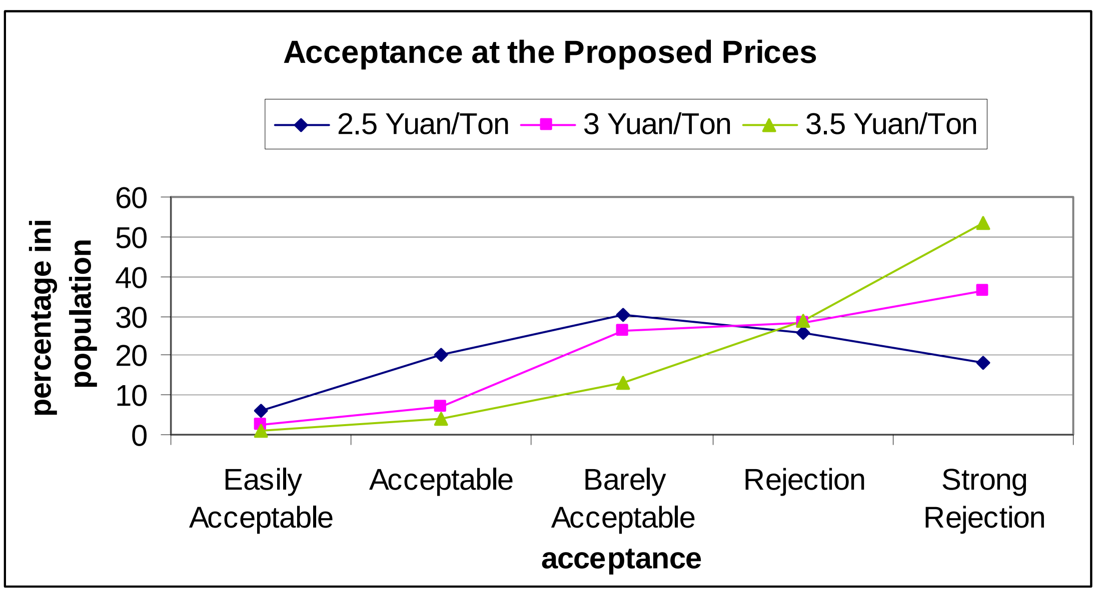


Figure 2. Acceptance Rate at the Proposed Prices



Appendix I.1 Domestic Water Tariffs in China in 2006 (Yuan/ton)

City	Water Price	Wastewater Fee	Total	City	Water Price	Wastewater Fee	Total
Beijing	2.8	0.9	3.7	Changsha	1.02	0.4	1.42
Tianjin	2.6	0.8	3.4	Nanjing	1.3	1	2.3
Shanghai	1.03	0.9	1.93	Hangzhou	1.35	0.5	1.85
Guangzhou	1.32	0.7	2.02	Zhengzhou	1.75	0.65	2.4
Shijiazhuang	2	0.6	2.6	Wuhan	1.1	0.8	1.9
Taiyuan	2.45	0.25	2.7	Shenzhen	1.9	0.9	2.8
Hohhot	1.95	0.45	2.4	Nanning	1.08	0.5	1.58
Shenyang	1.4	0.5	1.9	Haikou	1.55	0.6	2.15
Dalian	2.3	0.6	2.9	Urumqi	1.36	0.7	2.06
Hefei	1.9	0.51	2.41	Chengdu	1.35	0.8	2.15
Fuzhou	1.2	0.85	2.05	Guiyang	1	0.4	1.4
Xiamen	1.8	0.8	2.6	Kunming	2.05	0.75	2.8
Nanchang	0.88	0.22	1.1	Xian	1.95	0.5	2.45
Qingdao	1.8	0.7	2.5	Lanzhou	1.45	0.3	1.75
Changchun	2.1	0.4	2.5	Xining	1.3	0.27	1.57
Harbin	1.8	0.5	2.3	Yinchuan	1.3	0.4	1.7
Chongqing	2.3	0.5	2.8				

Sources: Rednet, 2006; World Bank 2007; Chongqing University 2007

Appendix I.2 Willingness-to-pay Sensitivity Analysis

Income Group	% Of obs.	Current Water Price (yuan/ton)	Mean WTP (Yuan/ton)		
			I	II	III
<200	2.70	2.18	1.92	2.42	2.45
201-400	4.20	2.14	1.74	2.14	2.18
401-700	11.10	2.17	1.92	2.29	2.33
701-1000	19.10	2.19	2.11	2.49	2.53
1,001-1,500	25.70	2.17	2.2	2.54	2.58
1,501-2,000	16.90	2.13	2.16	2.55	2.59
2,001-2,500	11.00	2.09	2.19	2.54	2.58
2,501-3,000	4.90	2.11	2.14	2.59	2.62
3,001-5,000	3.30	2.03	2.27	2.60	2.64
>5,000	1.10	2.14	2.22	2.56	2.60
Over all	100	2.15	2.12	2.50	2.54

Note: Scenario I: Barely Acceptable as 50%; Probably Yes as 75%
Scenario II: Barely Acceptable as 60%; Probably Yes as 75%
Scenario III: Barely Acceptable as 60%; Probably Yes as 80%

Appendix II: Questionnaire about Willingness- to-Pay (Version A)

We would like to know your level of satisfaction with your current household water services as well as your willingness to pay (WTP) for the service improvement.

Question: What are the major problems with the current water supply and sanitation services in your area? Please check all applicable answers on the following list.

1. Water supply is only available several hours a day or several days a week;
2. Many families do not have access to a piped water supply and have to purchase water from water venders or private wells;
3. Some households are connected to a municipal water supply but still need additional water sources;
4. Poor water quality;
5. Inadequate water draining system, causing environmental and public health problems;
6. Inadequate sewage water service; many toilets are not connected to the municipal sewage network;
7. Poor service attitude or maintenance delay;
8. Other problems (please specify): ________________________

At this moment, several regional or municipal projects are under consideration in order to solve the problems of the municipal water supply in your area. After these projects are completed, household water supply quality is expected to improve significantly. Specific improvements include:

1. Water will be available 24 hours a day and 7 days a week in this region/town;
2. Sufficient pressure to supply water to all floors in the apartment buildings;
3. The quality of water will reach or exceed the national water quality standards;
4. Every household will have a water meter and pay for its water tariff based on the water amount used by the household;
5. All toilets will be connected to the sewage network, which provides better environmental quality and reduces cleaning costs.

However, there are some financial issues in meeting these targets. It is projected that if enough funds can be raised, the projects can be implemented quickly to provide all households with improved water service as described above. The municipal government will try its best to keep a low water tariff in achieving the goals. However, without collecting sufficient water fees from households like yours, the water supply quality improvements may not be secured and the projects may not be implemented.

We would like to know the attitudes of households like yours toward the different water prices listed below. Please note that: (1) the unit water tariff listed below includes both water price and sewage fee, and the total amount of the water tariff that will be paid by your household depends on the amount of water consumed by your household (*In version*

B, no sewage fee is mentioned); (2) please consider your current income and other expenditures such as housing, food, electricity, clothing, entertainment, and saving etc.; (3) please also consider the problems in the current water supply service and your current expenditures on plumbing and storing water and on toilet cleaning; these expenditures can be reduced if the projects can be implemented; (4) the government will not force you to use the water supply system and you have the right to choose to either use or not use the improved water supply service.

In the following, we would like to know your views of the difficulties for your household to pay at different water prices for the improved water service. (Enumerators please help calculate corresponding total costs in a month based on the water amount this household consumed last month and the prices listed below.)

Price yuan/ton \\Your Opinion	Too high; strong rejection	High; rejection	Barely acceptable	Not high; acceptable	Very low; easily Acceptable
0.5 yuan/ton	A	B	C	D	E
1.0	A	B	C	D	E
1.5	A	B	C	D	E
2.0	A	B	C	D	E
2.5	A	B	C	D	E
3.0	A	B	C	D	E
3.5	A	B	C	D	E
4.0	A	B	C	D	E
4.5	A	B	C	D	E
5.0	A	B	C	D	E
6.0	A	B	C	D	E
7.0	A	B	C	D	E
8.0	A	B	C	D	E
9.0	A	B	C	D	E
10.0	A	B	C	D	E
12.0	A	B	C	D	E
15.0	A	B	C	D	E